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Subj: ArgoNeuT Recirculation Line Modification

During the Commissioning Run in Aug.'08 a low purification rate has been found, quite slower than expected. Possible reasons were discussed in several occasions.

Among these, the most probable seems to be related to the layout of the termination of the recirculation loop (liquefaction/purification).

The "stinger" (the single wall line coming down from the filters) is terminated in the gas volume on top of the liquid surface, at a temperature presumably rather high. The purified liquid drips out of the stinger and into the "cup" (with sintered metal bottom) partially immersed into the liquid.

Some effects could prevent an efficient LAr recirculation:
1. Dirty Gas Argon (in the GAr volume, contaminated by the outgassing of the warm walls, cables, plastic supports, ..), at the saturation Pressure imposed by the Set Point of the cryo-slow control, fills the return line up to the Purifier (at LAr Temp). It tends to move in the opposite direction against the recirculation loop, presumably lowering its flow rate.
2. Part of this Dirty Gas Argon gets liquified inside the stinger and coming back into the LAr volume may contaminate it (more effectively than by natural diffusion from the gas into the liquid).
3. Part of the Purified Liquid Argon from the Purifier gets evaporated while dripping out (and inside) the stinger into the cup, and does not (or only marginally) contribute to the LAr purification process.
4. Only the fraction of Purified Liquid Argon that reaches the LAr volume contributes to its actual purification. This fraction of the Purified Liquid Argon is released near the liquid surface and may evaporate into the GAr volume before diffusing inside the LAr volume (lowering in this way the efficiency of the purification loop).

The ideal solution to get rid of these (potential) problems is (as already discussed at FNAL) to remove the cup and extend the line from the purifier into the LAr volume, down to the bottom of the cryostat.

This solution is not easy to implement and would imply significant design/welding [*Bob, Mitch*].

A different option has been proposed [*Bob, Mitch*]:

- to add an additional internal fill pipe that would attach to the cup. This new line would take all of the liquid coming out of the bottom of the cup and route it down and around to near the bottom of the cryostat. So the liquid would still drip out of the stinger and into the cup, but then it would make its way to the bottom of the tank.

I (personally) believe that this solution would be effective only to get rid of pb.(4), while the other three remain unaffected.

However, if the "ideal solution" is not viable maybe an "intermediate" option can be considered (the difficulty of the implementation I cannot judge from here, but I expect to be negligible):

- to remove the cup and just extend the return line (purified LAr from the purifier) by ~10 inch. (or more if possible) up to have the end of it well immersed into the liquid. In this way pb.s (1 to 3) should be solved and only pb.(4) could remain only partially solved.

The question is how to seal the extension line ("~10 inch. pipe") to the end of the existing line. The easiest way could be by using a straight tube fitting with two side connection (e.g. Swagelock Tube Fittings - Straights | Connection 2 Size : 1 inch shown in in Figure [Left]).
Alternatively by threatening the ends of the existing line (stinger) and of the "10 inch. pipe" and screwing the one into the other.

This "intermediate solution" doesn't require the pipe to be extended to the bottom of the cryostat (complicated design/ welding) but should provide more efficient recirculation of the liquid.

The "ion formation" should be avoided with this type of solution, in any case the "10 inch. pipe" also could be terminated at the immersed end with a sintered disk.

The intervention could be performed on the open top flange and after positioned onto the cryostat.